

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2022/2023

TAI2151 – ARTIFICIAL INTELLIGENCE FUNDAMENTALS
(All sections)

06 October 2023
9.00 a.m – 11.00 a. m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 4 pages with 5 Questions only.
2. Answer **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

QUESTION 1 (10 MARKS)

Figure 1 illustrates a search space, where S is the start node and $G1$, $G2$, and $G3$ are goal states. Search with multiple goals proceeds the same way as search with a single goal, except that the algorithm terminates when any of the goal states in the goal set is reached through an optimal path. The links are labeled with the cost of traversing them and the heuristic cost to a goal is reported inside the nodes.

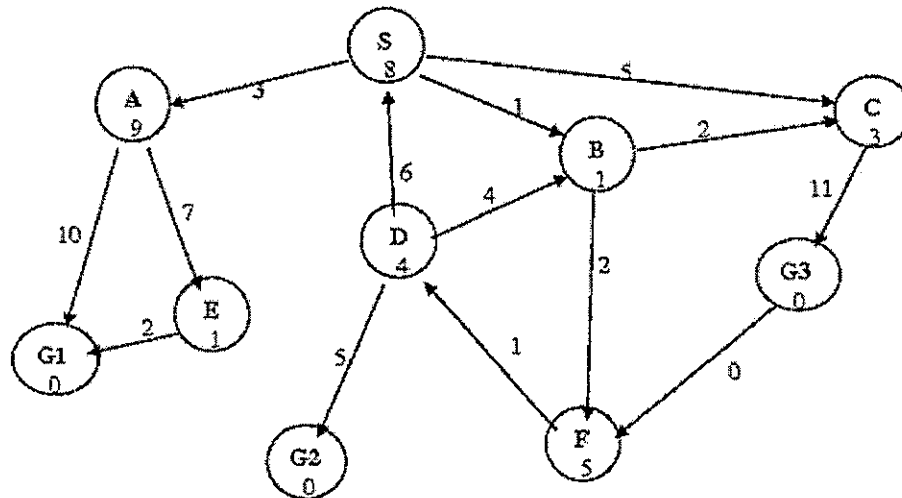


Figure 1: Search space S with goal states $G1$, $G2$, and $G3$.

For each of the following search strategies, indicate which goal state is reached (if any) and list, in order, all the states visited during the search. In the case of ties, the algorithm should expand nodes in lexicographical order (A before B, etc.).

(a) Best-First Search

[5 MARKS]

(b) A*

[5 MARKS]

Continued

QUESTION 2 (10 MARKS)

- (a) The single most important idea in formal logic is that the meaning of a sentence can be represented as a set of possible worlds.
 Given a universe with propositional symbols P , Q , R , and S as shown in (1), (2), and (3) how many interpretations are there in the meaning of the following KB? **[5 MARKS]**

$(P \wedge Q)$	$(R \wedge S)$	(1)
$(P \wedge Q)$	$(R \wedge S)$	(2)
$\neg (P \wedge Q)$	$(\neg P \vee \neg Q)$	(3)

- (b) The following four questions assume **we are in a world with four propositional symbols**. For each question, the answer might be “infinite”. **[5 MARKS]**
- (i) How many possible **interpretations** are there?
 - (ii) How many possible **meanings** are there?
 - (iii) How many possible **sentences** are there?
 - (iv) How many possible **knowledge bases** are there?

QUESTION 3 (10 MARKS)

Consider the following KB :

$\exists u. \text{ Tenured}(u)$
 $\forall v. \text{ Tenured}(v) \Rightarrow \text{Fat}(v)$
 $\forall w. \text{ Fat}(\text{Boss}(w)) \Rightarrow \text{Fat}(w)$
 $\text{Boss}(\text{Andrew}) = \text{Bob}$
 $\neg \text{Tenured}(\text{Bob})$

- (a) Is “Fat” a predicate symbol, a function symbol, or a constant symbol?
 Justify your answer. **[2 MARKS]**
- (b) Is “Boss” a predicate symbol, a function symbol, or a constant symbol?
 Justify your answer. **[2 MARKS]**
- (c) Assuming that Andrew and Bob are distinct objects, and assuming that there are no other objects in the universe, give the full, set-theoretic meaning of the above KB , expressed as a list of predicate-logic interpretations (**HINT**: The number of interpretations in the meaning is strictly greater than 1 and strictly less than 4). **[6 MARKS]**

Continued

QUESTION 4 (10 MARKS)

As per decision tree studied, finding the smallest decision tree consistent with data matters. Assume that all attributes (inputs and output) are binary with no pruning, construct an example data set in which:

- (a) it is possible to find a tree that gets zero training set error, [3 MARKS]
- (b) and our decision tree learning algorithm succeeds in finding a tree with zero training set error, [3 MARKS]
- (c) but there is a smaller, simpler, tree that also has zero training set error but which our decision tree learning algorithm fails to find. [4 MARKS]

NOTE: You **must** explain the idea behind your example dataset, and why our decision tree learning algorithm fails to find the smallest solution.

HINT: Main objective of this question is creating a counterexample to the hypothesis already studied.

Continued

QUESTION 5 (10 MARKS)

Consider three neural network architectures, A, B, and C as illustrated in Figure 2. All A, B, and C neural networks take a single (one) real-value input x and predict the output y which is constrained to be between 0 and 1 by a conventional sigmoid function

$$g(z) = 1 / (1 + e^{-z}).$$

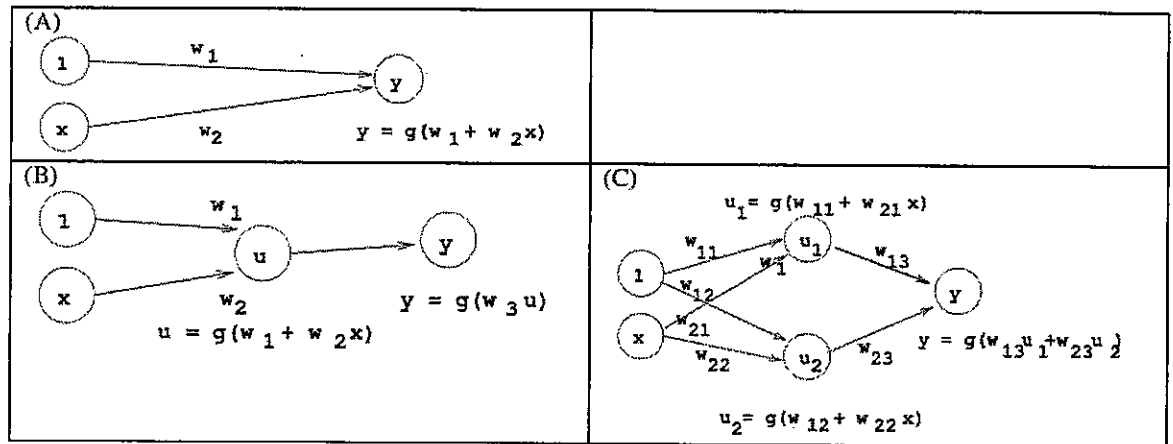
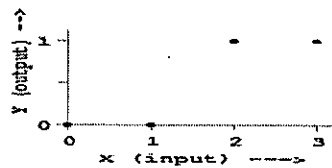


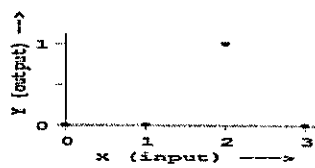
Figure 2: A, B, and C Neural Network Architectures

Which neural network architecture(s) A, B, and C is (are) capable of achieving sum of squared error less than 0.01 based on the four points illustrated in Figures 3, 4, and 5?

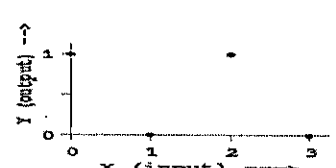
NOTE: Your answer shall be "none" or subset of neural network architectures {A, B, C}.



(a) Figure 3



(b) Figure 4



(c) Figure 5

[3 MARKS]

[3 MARKS]

[4 MARKS]

Continued